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(54) **Photoelectric converting device.**

(57) A photoelectric converting device comprises a first semiconductor area of a first conductive type, a second semiconductor area of a second conductive type, and a third semiconductor area of the first conductive type. A charge is photoelectrically excited by light incident on second semiconductor area, and is derived from the first semiconductor area after amplification.

A fourth semiconductor area of the first conductive type is formed in contact with the second semiconductor area and so positioned as to oppose to the third semiconductor area.

During an operation of the device, a depletion layer extending from the interface between the third and fourth semiconductor areas reaches a depletion layer extending from the interface between the third and second semiconductor areas.

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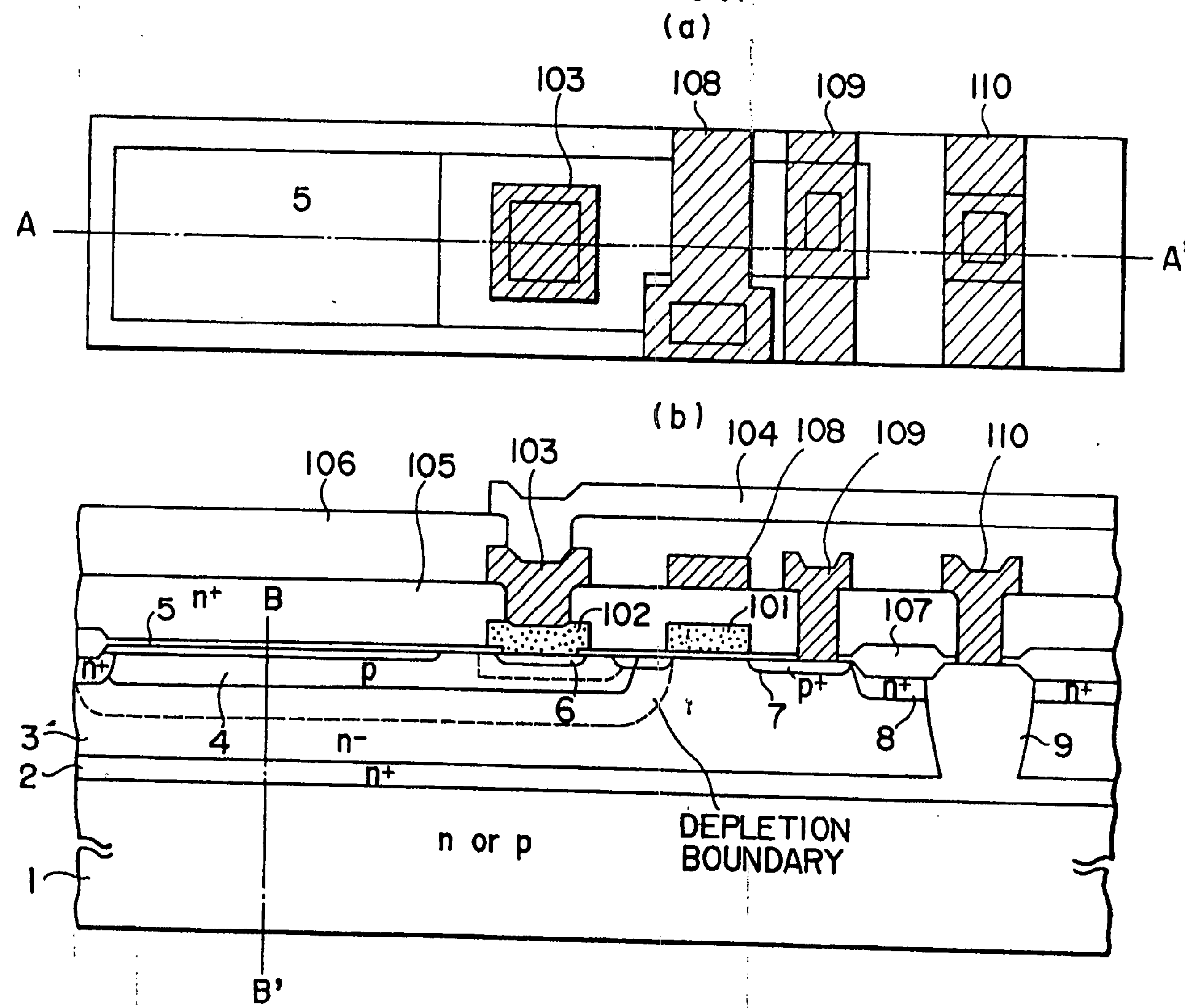
FIG.1


(a)
103
108
109
110
5
A
A'
(b)
106
105
103
104
108
109
110
5
n+
B
102
101
107
n+
p
6
4
n−
7
p+
n+
8
n+
9
3'
2
n+
1
n or p
DEPLETION BOUNDARY
B'

PHOTOELECTRIC CONVERTING DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a photoelectric converting device.

Related Background Art

In the conventional art of the photoelectric converting device, there is for example known a device of bipolar transistor type.

Fig. 8 shows, in a schematic cross-sectional view, an example of the conventional bipolar photoelectric converting device, in which there are provided a silicon substrate 1 of n or p type by doping of an impurity such as phosphor (P), antimony (Sb) or arsenic (As) ; an n^+ area 2 formed for example by an epitaxial process ; an n^- area 3 of lower impurity concentration serving as a collector region ; a p-area 4 serving as a light receiving base area for accumulating photogenerated carriers ; an n^+-area 6 serving as an emitter ; a p^+ area 7 constituting the drain of an MOS transistor ; and an n^+-area 8 serving as a channel stop or connected with the collector.

However, such conventional photoelectric converting device has been associated with a drawback that the photosensitivity thereof is not always sufficient, and such drawback is more conspicuous in a miniatuarized photoelectric converting device.

In the conventional bipolar photoelectric converting device, the photosensitivity can be approximately represented as follows :

$$S_e = \frac{i_p \cdot A_s \cdot t_s}{C_{bc}} \quad \cdots (1)$$

wherein i_p is the photoinduced current density per unit area ; A_s is the aperture area ; t_s is the accumulation time ; and C_{bc} is the base-collector capacitance.

As will be apparent from the equation (1), the photosensitivity Se decreases with the increase of the base-collector capacitance C_{bc}.

SUMMARY OF THE INVENTION

In consideration of the foregoing, an object of the present invention is to reduce the base-collector capacitance C_{bc} in the above-explained equation (1), thereby improving the photosensitivity of the photoelectric converting device.

Another object of the present invention is to provide a photoelectric converting device provided at least with a first semiconductor area of a first conductive type, a second semiconductor area of a second conductive type, and a third semiconductor area of the first conductive type and adapted to take out the charge, generated by the light irradiating said second semiconductor area, from said first semiconductor area after amplification, comprising :

a fourth semiconductor area of the first conductive type, formed in contact with said second semiconductor area and positioned correspondingly to said third semiconductor area ;

wherein, in the operation of said device, a depletion layer extending from the interface between said third and fourth semiconductor areas reaches a depletion layer extending from the interfaces of said third and second semiconductor areas.

Still another object of the present invention is to provide the above-mentioned photoelectric converting device in which the thickness of said fourth semiconductor area is smaller than the penetration distance of blue light and is equal to or less than 1/2 of the diffusion length of minority carriers in said fourth semiconductor area.

Still another object of the present invention is to provide the above-mentioned photoelectric converting device further comprising a fifth s miconductor layer of the second conductive type, formed on said second semiconductor area and having a higher impurity concentration than in said second semiconductor area, wherein said first semiconductor area is formed on said fifth semiconductor area.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1(a) is a schematic plan view of a first embodiment of the photoelectric converting device of the present invention ;

Fig. 1(b) is a schematic cross-s ctional view of said first embodiment ;

Fig. 2(a) is a magnified view of a portion B-B' in Fig. 1(b) ;

Fig. 2(b) is a potential chart in the direction of depth of Fig. 2(a) ;

Fig. 3 is a chart showing an example of impurity distribution in the areas shown in Figs. 2(a) and 2(b) ;

Fig. 4 is a chart showing the relation between the carrier life time and the diffusion length of positive holes in the n-type area ;

Fig. 5 is a chart showing the relation of V_R and W in silicon, with N_A as parameter.

Fig. 6(a) is a schematic plan view of a second embodiment of the photoelectric converting device of the present invention ;

Fig. 6(b) is a schematic cross-sectional view of said second embodiment ;

Fig. 7(a) is a schematic plan view of a third embodiment of the photoelectric converting device of the present invention,

Fig. 7(b) is a schematic cross-sectional view of said third embodiment ; and

Fig. 8 is a schematic cross-sectional view of an example of the conventional bipolar photoelectric converting device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the present invention, the above-mentioned fourth semiconductor layer is present and is provided in such a manner that, in the operation of the device, the depletion layer extending from the interface between said third and fourth semiconductor layers reaches the depletion layer extending from the interface between said third and second semiconductor layers, whereby the capacitance of the base area can be diminished to improve the photosensitivity of the device.

Also in the present invention, the loss in sensitivity to blue light, resulting from the presence of said fourth semiconductor layer, can be prevented by selecting the thickness of said fourth semiconductor layer in such a manner that said thickness is smaller than the penetration length of blue light and is equal to or less than 1/2 of the diffusion length of minority carriers in said fourth semiconductor layer.

Also in the present invention, the presence of the area of the second conductive type of a high impurity concentration as explained above allows to determine the impurity concentration of said second semiconductor layer without affecting the characteristics of the bipolar transistor.

In the following the present invention will be clarified in detail by embodiments thereof shown in the attached drawings.

[First embodiment]

Figs. 1(a) and 1(b) schematically illustrate a first embodiment of the photoelectric converting device of th present invention, respectively in a plan view of a photoelectric converting cell, and a vertical cross-sectional view along a line A-A' in Fig. 1(a).

As shown in Figs. 1(a) and 1(b), said photoelectric converting cell comprises :

a substrate 1 formed as n-type by doping of an impurity such as phosphor (P), antimony (Sb) or arsenic (As), or as p type by doping of an impurity such as boron (B) or aluminum (Al) ;

an embedded n^+-area 2 formed on said substrate 1 ;

an n^--area 3 of a low impurity concentration, formed for example by an epitaxial process on the embedded area 2 and serving as a collector area ;

a p^--area 4 doped with an impurity such as boron (B), serving as a light-receiving area and a base area, and formed on the n^--area 3 for example by impurity diffusion, ion implantation or epitaxial growth ;

an n^+-area 5 formed at the surface of the p^--area 4 ;

an n^+-area 6 constituting the emitter of a bipolar transistor ;

a p^+-area 7 constituting the drain of a MOS transistor ;

an n^+-area 8 serving as a channel stop and also connected to the collector ;

an n^+-area 9 for reducing the collector resistance of the bipolar transistor ;

an electrode 101 composed of polysilicon or metal and serving as the gate of the MOS transistor ;

a wiring 108 connected to said electrode 101 ;

wirings 102, 103, 104 composed of polysilicon or metal and connected to the emitter of the bipolar transistor ;

a wiring 109 connected to th drain of the MOS transistor ;

an electrode 110 connected to the n^+-area 9 ;
and
insulation films 105, 106, 107 for separating the electrodes, wirings and device elements.

For th purpose of simplicity, the insulation films 105, 106, 107 and the wiring 104 are omitted in Fig. 1(a).

Fig. 2(a) is a magnified view of a portion B-B' in Fig. 1(b), and Fig. 2(b) is a potential chart in the direction of depth of Fig. 2(a).

In the conventional photoelectric converting device, the depletion layer does not completely cover the bas area 4, because of the absence of the n+-area 5 and because the impurity concentrations at the pn junction between the collector (n^-) area 4 and the base (p) area have a relation $|p| > |n|$. Consequently the surface of the base area 4 is not depleted but contains a neutral area. In practice the complete depletion to the surface is difficult to realize in case the area 4 is used as the base. The complete depletion to the surface, if achieved by a special structure, induces carrier generation at the interface with an insulating material, thus increasing dark current which is a major drawback in the photoelectric converting device.

In the present invention, a surfacial n^+-area 5 is provided to form an n^+p junction, thereby extending the depletion layer also from the surface side, and thus depleting the p-area completely in the direction of depth thereof.

Fig. 3 is a chart showing an example of impurity distribution in the areas shown in Figs. 2(a) and 2(b).

As the p-area 4 is formed by ion implantation followed by thermal treatment or thermal diffusion, the impurity concentration is highest at the surface and gradually decreases with the depth. Consequently, the depletion layer extending from the n^--area enters the p-area 4 but cannot easily reach the upper part of the p-area 4 because the extension has to be done in the increasing direction of impurity concentration. On the other hand, the depletion layer extending from the n^+-area 5 can easily reach the pn^- junction because the extension is in the decreasing direction of impurity concentration, so that the p-area 4 can be readily and completely depleted in the entire depth thereof. This phenomenon can explain a fact that the emitter-collector breakdown voltage is high in a normal bipolar transistor but is low in an inverted bipolar transistor in which the emitter and the collector are inverted. The expansion of the depletion layer from the side of n^+-area is easy, and complete depletion of the p-area can be easily achieved with a voltage not exceeding 5 V.

The depletion of the base area 4 under the n^+-area 5 drastically reduces the base-collector electrostatic capacitance C_{bc}.

Although the entire base area 4 contributes to the capacitance Cbc in the conventional structure, the presence of the n^+-area 5 excludes the capacitance of the p-area 4 corresponding to the area of said n^+-area 5 from the capacitance C_{bc}, so that said capacitance C_{bc} is almost solely governed by the capacitance around the emitter (see Fig. 1(b)). Said capacitance C_{bc} can therefore be easily reduced to 1/2 - 1/10 of the conventional value, depending on the pattern design.

Besides the dark current decreases in comparison with that in the conventional structure, because the photogenerated positive holes are not accumulated on the semiconductor surface but in the semiconductor and accumulated by drifting in C_{bc} and C_{be} around the emitter as the result of potential distribution shown in Fig. 2(b), and also because the presence of the n^+-area at the semiconductor surface avoids the carrier formation at the interface with the insulating material. However, the depletion layer extending from the n^+-area has to reach the depletion layer extending from the pn^- junction, since, otherwise, the base-collector capacitance becomes larger than in the conventional structure (almost doubled in area).

In the following there will be explained the spectral sensitivity of the photoelectric converting device of the present embodiment.

Said spectral photosensitivity can be approximately represented as follows :

$$S(\lambda) = \frac{\lambda}{1.24} \exp(-\alpha \cdot x_d)$$

$$\times \{1 - \exp(-\alpha \cdot W) \cdot T\} \qquad [A/W] \quad \cdots (2)$$

wherein λ is the wavelength of light ; α is the absorption coefficient of light (cm^{-1}) ; x_d is thickness of the insensitiv ar a (n^+-area 5) ; W is width of the high sensitivity ar a (depletion layer) ; and T is the proportion of light entering the semiconductor (transmittance).

As will be understood from the equation (2), the thickness x_d should preferably be as small as possible, because the spectral sensitivity is strongly affected by x_d.

In case of silicon, the absorption coefficients for blue (λ = 0.45 μm), green (λh = 0.53 μm) and red (λh = 0.65 μm) ar r spectively about 2×10^4 cm^{-1}, 7.5×10^3 cm^{-1} and 3×10^3 cm^{-1}. In consideration of a half-peak

width of about 0.05 μm for each color, the light absorption in silicon takes place sufficiently at a depth of about 1 μm for blue color, 2 μm for green color and 5 μm for red color. Consequently the blue light is most strongly influenced by the thickness x_d of the neutral area at the semiconductor surface, so that the sensitivity for blue color is deteriorated.

However, even the n^+-area is not without light absorption. Nevertheless, the probability of transition is modified to a certain extent because free carriers are already present in the conduction band, and the efficiency is lowered to a certain extent because the minority carriers generated by light absorption partly recombine with the majority carriers in the course of diffusion. Fig. 4 shows the result of calculation on the relation between the carrier life time and the diffusion length for the positive holes in the n-area. For example, for $N = 10^{19}$ cm^{-3}, there is obtained L_p of about 5 μm, which is considerably long for the diffusion length. Therefore, since the penetration distance ($1/\alpha$) for the blue light in question is about 0.5 μm, the difficulty can be mostly prevented by selecting the thickness of said n^+-area 5 less than said diffusion distance and not exceeding $1/\alpha$ of L_p, namely so as to satisfy a condition :

$$x_d < \left(\frac{1}{\alpha}\right)_{(Blue)},\ \frac{1}{2} L_p (n^+) \qquad \cdots (3)$$

Besides the problem of sensitivity to blue light is alleviated since the photosensitivity is generally improved in comparison with that in the conventional photoelectric converting device, as explained above.

The width of the depletion layer at the n^+p junction can be represented in the following manner, in a step junction approximation :

$$W = \left\{ \frac{2 \cdot \epsilon_s}{q} \cdot \frac{N_A + N_D}{N_A \cdot N_D} \cdot (V_{bi} + V_R) \right\}^{1/2} \qquad \cdots (4)$$

$$V_{Bi} = \frac{kT}{q} \cdot \ln \frac{N_A \cdot N_D}{n_i^2} \qquad \cdots (5)$$

wherein W is the width of depletion layer ; N_A is the impurity density of p^--area ; N_D is the impurity density of n^--area ; ε_s is the dielectric constant ; n_i is the true carrier density ; and V_r is the reverse bias voltage.

Since $N_D \gg N_A$ in an n^+p junction, the above-mentioned equation (4) can be approximated as follows :

$$W \simeq \left(\frac{2 \cdot \epsilon_s}{q} \cdot \frac{1}{N_A} \cdot (V_{bi} + V_R) \right)^{1/2} \qquad \cdots (4)'$$

Fig. 5 is a chart showing the relation between V_R and W in silicon, with N_A as a parameter.

In the ordinary photoelectric converting device in which 5 V is applied to the collector, the effect of the present invention can be obtained by selecting W, corresponding to N_A for V_R of about 3 V, smaller than the thickness of the p-area 4. Stated differently, the thickness of the base area should be selected smaller than W corresponding to the base impurity concentration N_A, for a given value of V_R. Or, the thickness x_d of the p-area 4 positioned between the n^+-area 5 and the n^--area 3 should be selected smaller than W determined by N_A and V_R.

[Second embodiment]

Figs. 6(a) and 6(b) illustrate a second embodiment of the photoelectric converting device of the present invention, respectively in a plan view and in a vertical cross-sectional view along a line A-A' in Fig. 6(a).

Different from the device of the foregoing first embodiment, the device of the present embodiment is pro-

vided with a p^+-area 20 only below the emitter area 6. The presence of said p^+-area 20 provides an advantage that the impurity concentration of the p-area can be arbitrarily determined, without being influenced by the characteristics of the bipolar transistor.

Such photoelectric converting device showed, in an operation test, a remarkable improvement in the photosensitivity, in comparison with the conventional device.

[Third embodiment]

Figs. 7(a) and 7(b) illustrate a third embodiment of the photoelectric converting device of the present invention, respectively in a plan view of a photoelectric converting cell and in a vertical cross-sectional view along a line A-A' in Fig. 7(a).

In the structure shown in Figs. 7(a) and 7(b), the lead wire from the emitter electrode 103 is taken out directly, without the polysilicon layer 102. Also a barrier metal or the like may be made present between the layers 103 and 6.

Such photoelectric converting device showed, in an operation test, a remarkably improved photosensitivity, in comparison with the conventional device.

The foregoing first to third embodiments have been limited to the application of the present invention to a line sensor, but similar effect can naturally be obtained in the applications to other photoelectric conversion devices, for example area sensors.

As detailedly explained in the foregoing, the present invention allows to drastically reduce the base-collector capacitance C_{bc} of the bipolar transistor, thereby remarkably improving the photosensitivity of the photoelectric converting device.

Also according to the present invention, the presence of a surfacial n^+-area of high impurity concentration reduces the current generated at the interface between SiO_2 and Si, whereby the dark current is reduced to decreases the noises and to significantly improve the S/N ratio. Also the dynamic range is widened so that the signal can be obtained down to a low irradiation level.

The absorption of blue light is maintained by making the n^+ layer 5 to be thin. Blue light typically has, for example, a wavelength no greater than 530 nm, and preferably light absorption is also made good for light of wavelength 450 nm or even less.

Claims

1. A photoelectric converting device provided at least with a first semiconductor area of a first conductive type, a second semiconductor area of a second conductive type, and a third semiconductor area of the first conductive type, and adapted to take out the charge, formed by the light irradiating said second semiconductor area, from said first semiconductor area after amplification, comprising :
   a fourth semiconductor area of the first conductive type, formed in contact with said second semiconductor area and so positioned as to oppose to said third semiconductor area ;
   wherein, in the operation of said device, a depletion layer extending from the interface between said second and fourth semiconductor areas reaches a depletion layer extending from the interface between said third and second semiconductor areas.

2. A photoelectric converting device according to claim 1, wherein the thickness of said fourth semiconductor area is smaller than the penetration distance of blue light and is equal to or less than the diffusion length of minority carriers in said fourth semiconductor area.

3. A photoelectric converting device according to claim 1, further comprising a fifth semiconductor layer of the second conductive type, formed on said second semiconductor area and having a higher impurity concentration than in said second semiconductor area, wherein said first semiconductor area is formed on said fifth semiconductor area.

4. A photoelectric converting device according to claim 2, further comprising a fifth semiconductor layer of the s cond conductive type, formed on said second semiconductor area and having a higher impurity concentration than in said second semiconductor area, wherein said first semiconductor area is formed on said fifth semiconductor area.

5. A photoelectric converting device according to claim 1 wherein the thickn ss of the fourth semiconductor

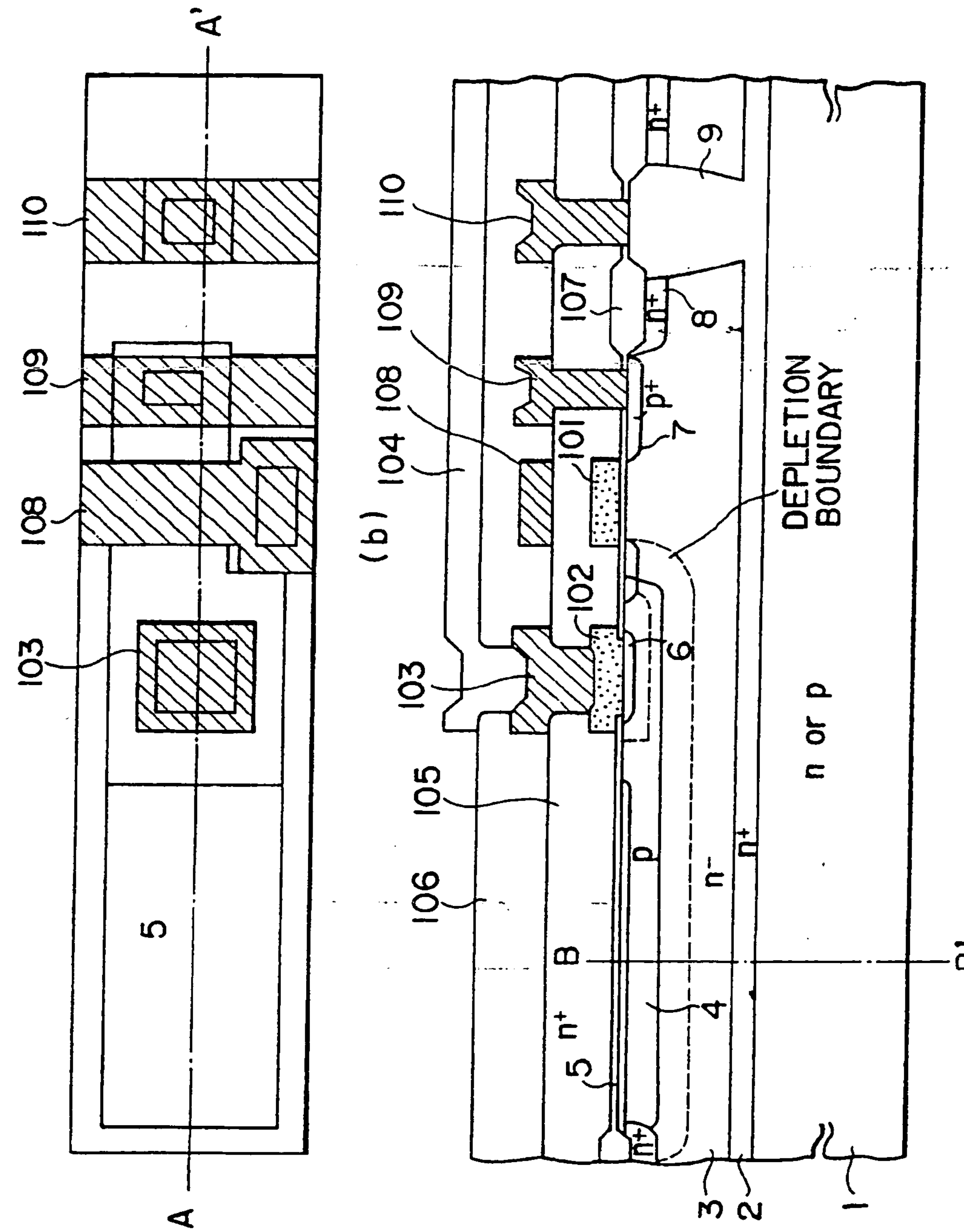
region is smaller than the penetration distance of a wavelength of light not greater than 530 nm.

6. A photoelectric converting device according to claim 1 wherein the thickness of the fourth semiconductor region is smaller than the penetration distance of a wavelength of light not greater than 450 nm.

7. A photoelectric conversion device comprising a first semiconductor region (3) of a first conductivity type, a second semiconductor region (4) of a second conductivity type, and a third semiconductor region (5) of the first conductivity type, the said regions being arranged so that the second region (4) is between the first and third regions (3, 5) and charges entering or being retained in the second region (4) in response to incident light energy, the device further comprising biassing means for biassing the first and third regions (3, 5) so that a depletion layer formed in the second region (4) due to the first region (3) meets a depletion layer formed in the second region (4) due to the third region (5).

8. A photoelectric conversion device comprising a bipolar phototransistor having an emitter lead-out (103, 104) which contacts the emitter region (6) with a metal-semiconductor junction.

FIG.1


(a)
A
A'
103
108
109
110
5
(b)
106
105
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102
6
101
108
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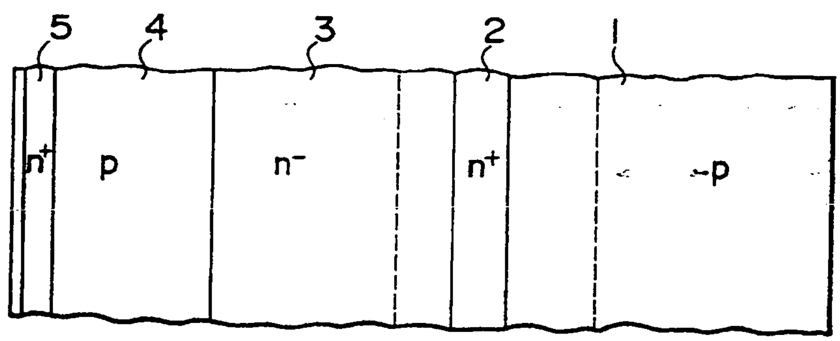
109
107
110
8
9
7
5
n+
p+
p
n-
n or p
DEPLETION BOUNDARY
B
B'
4
3
2
1

FIG.2

(a)



(b)

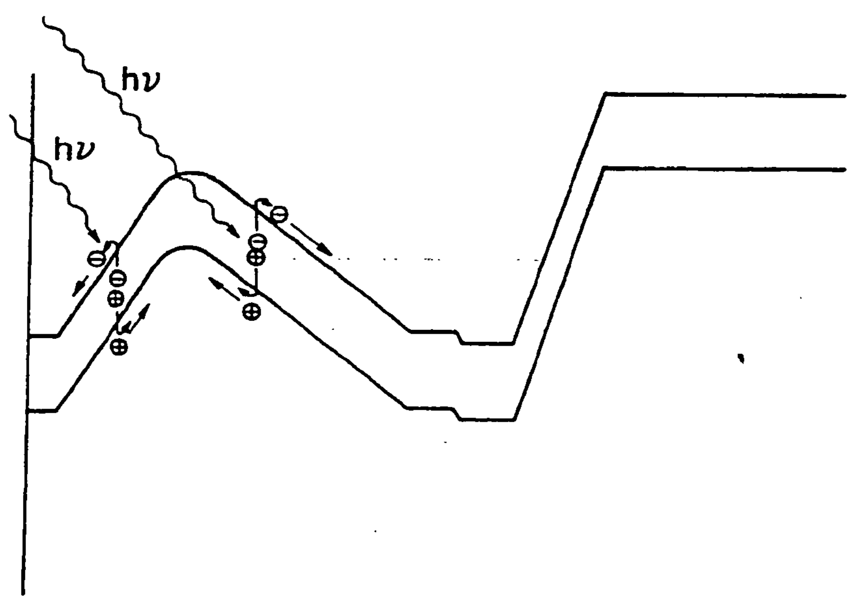


FIG.3

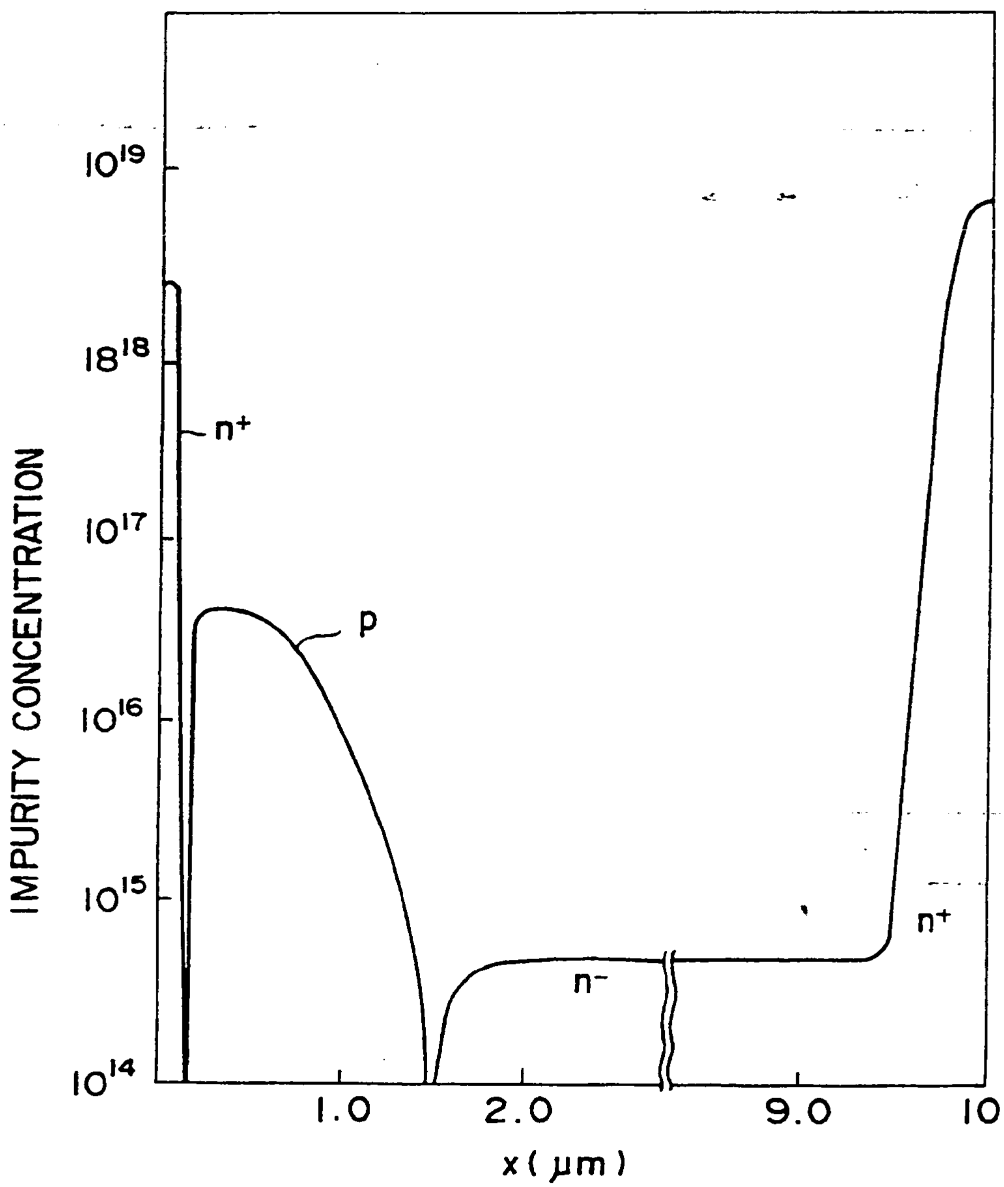

IMPURITY CONCENTRATION
10^{19}
18^{18}
10^{17}
10^{16}
10^{15}
10^{14}
n^+
p
n^-
n^+
1.0
2.0
9.0
10
x (μm)

FIG.4

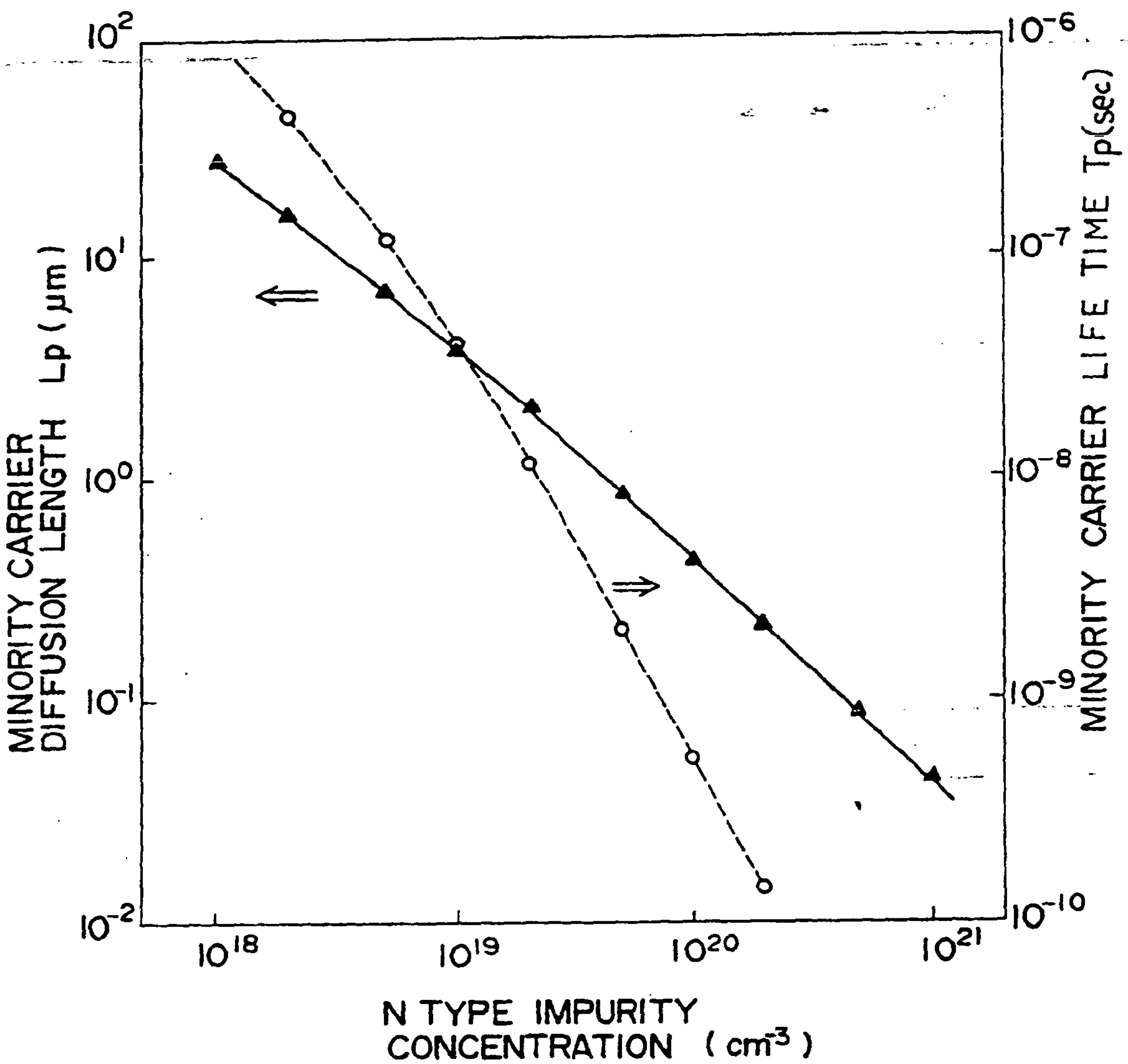

10^2
10^1
10^0
10^-1
10^-2
10^-6
10^-7
10^-8
10^-9
10^-10
10^18
10^19
10^20
10^21
MINORITY CARRIER DIFFUSION LENGTH Lp (μm)
MINORITY CARRIER LIFE TIME Tp(sec)
N TYPE IMPURITY CONCENTRATION (cm^-3)

FIG. 5

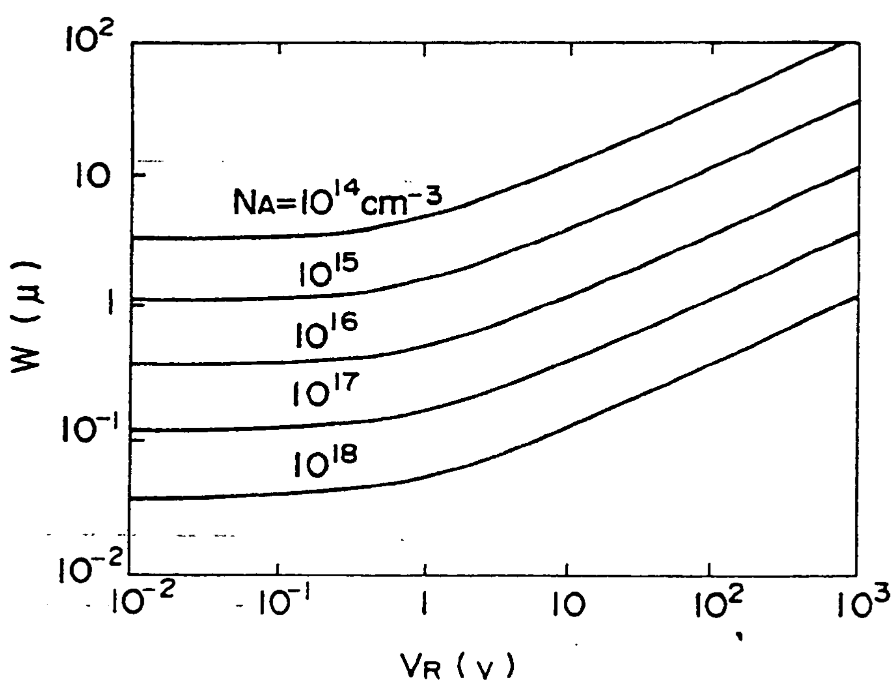
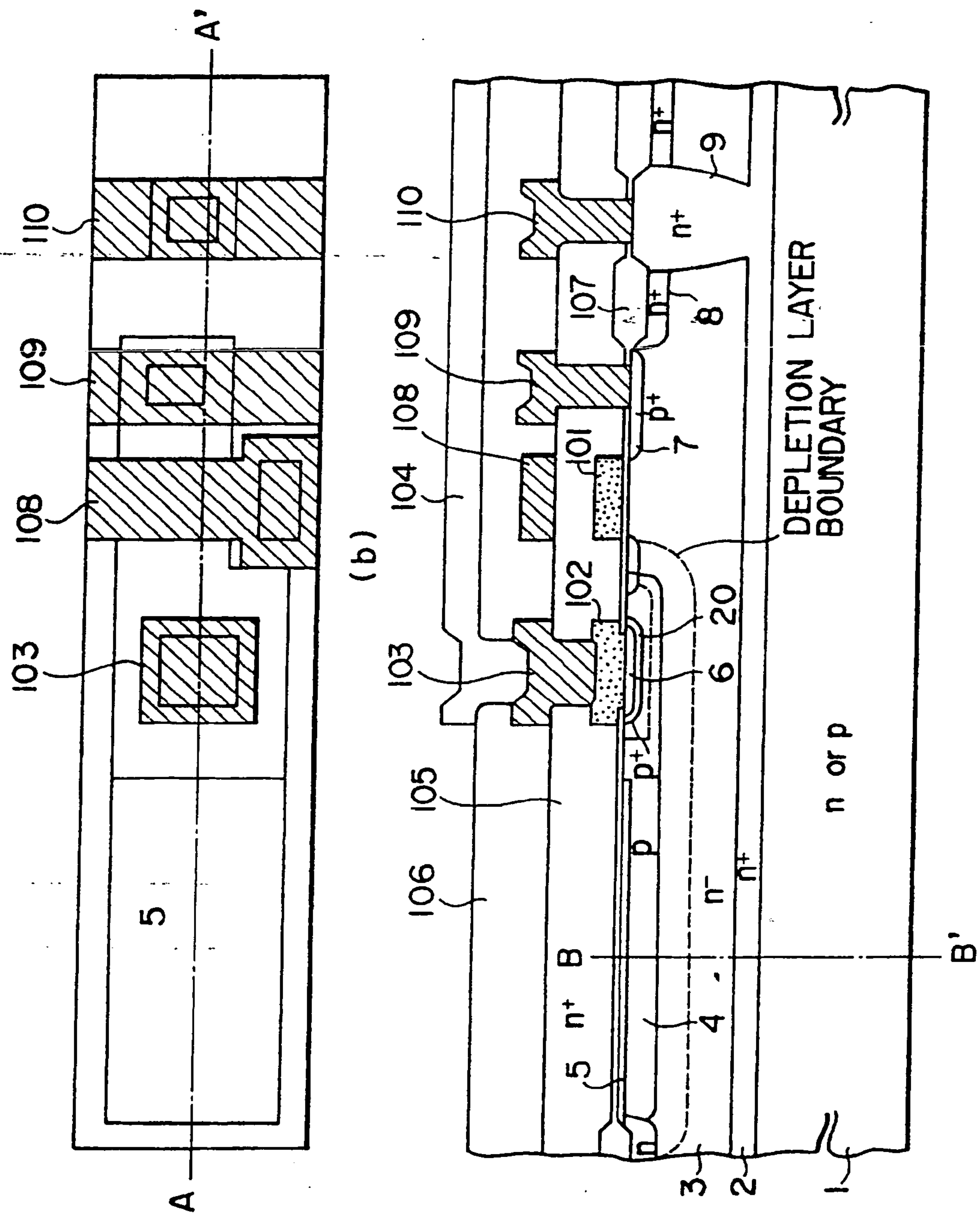

10^2
10
1
10^{-1}
10^{-2}
W (μ)
$N_A = 10^{14} cm^{-3}$
10^{15}
10^{16}
10^{17}
10^{18}
10^{-2}
10^{-1}
1
10
10^2
10^3
V_R (v)

FIG.6

(a)

(b)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110
5
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B'
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105
106
101
102
107
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n-
n or p
DEPLETION LAYER BOUNDARY
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6
7
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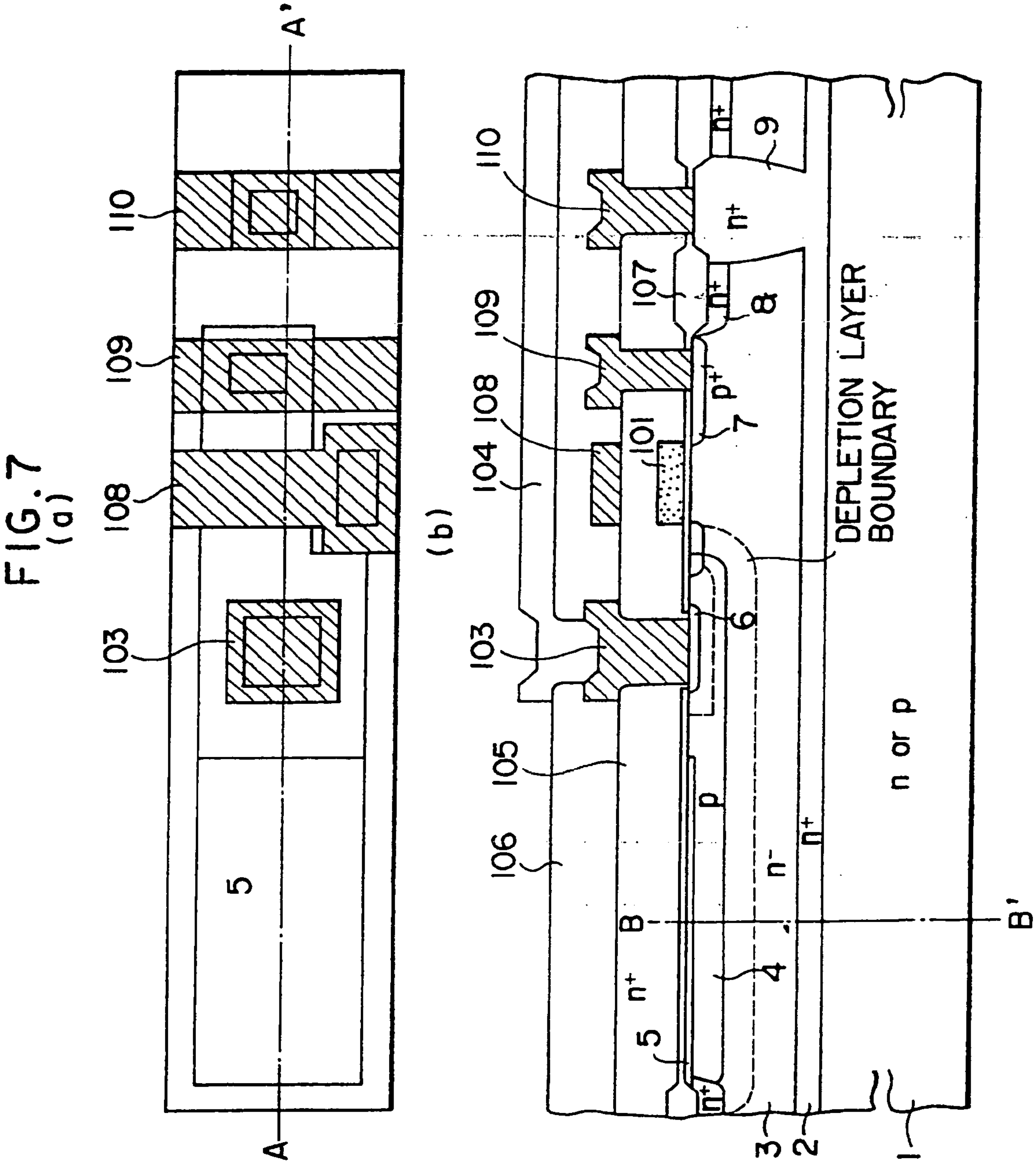
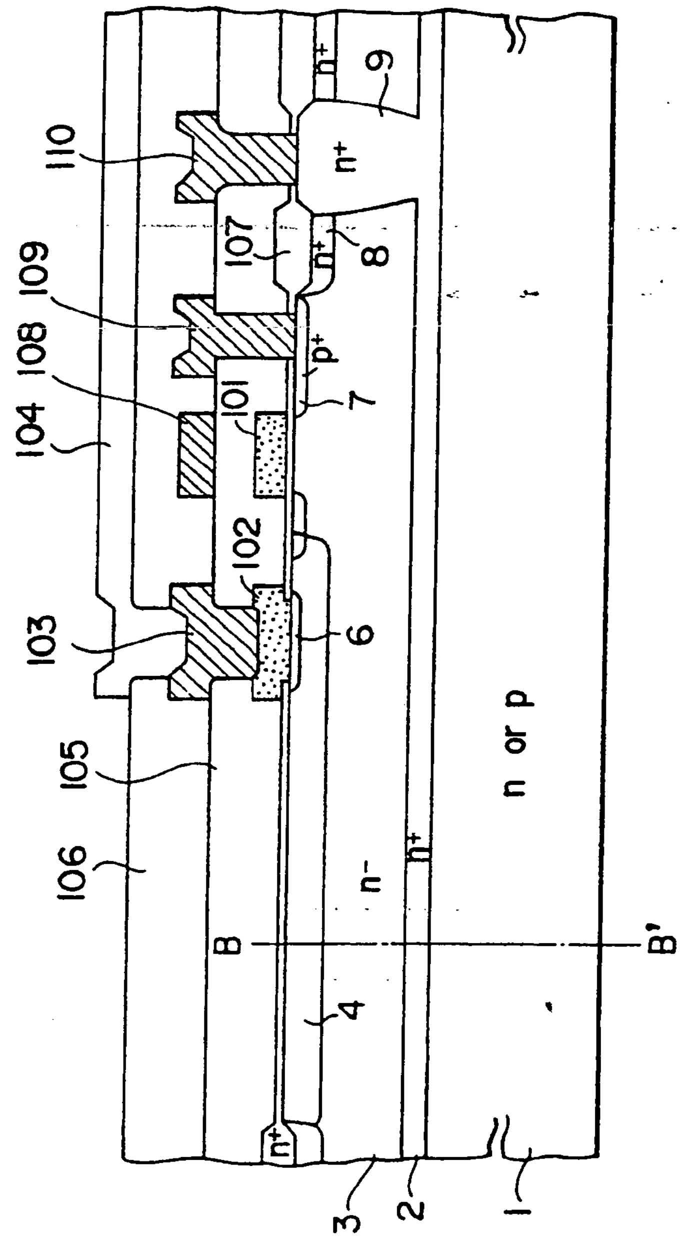


(a)
A
A'
103
108
109
110
5
(b)
106
105
104
103
108
109
110
101
107
DEPLETION LAYER BOUNDARY
n⁺
p
n⁻
p⁺
n or p
B
B'
1
2
3
4
5
6
7
8
9

FIG. 7

FIG.8



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A fourth semiconductor area of the first conductive type is formed in contact with the second semiconductor area and so positioned as to oppose to the third semiconductor area.

During an operation of the device, a depletion layer extending from the interface between the second and fourth semiconductor areas reaches a depletion layer extending from the interface between the third and second semiconductor areas.

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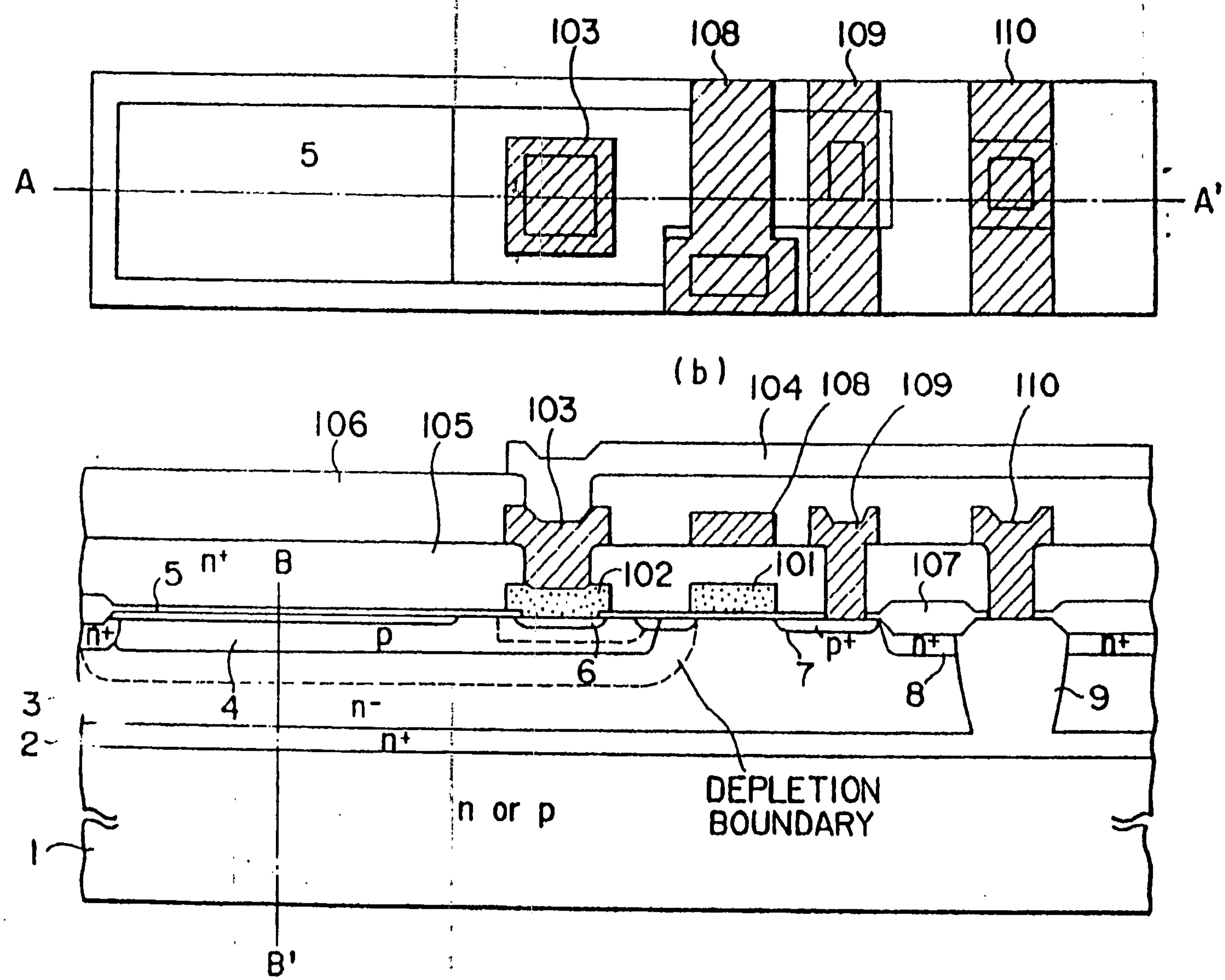
FIG.1

(a)


103
108
109
110
5
A
A'
(b)
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103
104
108
109
110
5
n+
B
102
101
107
n+
p
p+
n+
n+
6
7
8
4
3
n-
9
2
n+
n or p
DEPLETION
BOUNDARY
1
B'

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 90 31 3687

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN, vol. 13, no. 86 (E-729)(3434), 28 February 1989 & JP-A-63 263 774 (MATSUSHITA ELECTRIC IND. CO. LTD) 31 October 1988		H 01 L 31/11 H 01 L 27/144
	* Whole abstract *	1,7	
	--		
A	US-A-4 649 409 (M ROPPONGI et al.)		
	* Whole document *	1,7	
X	* Column 3, lines 18-46 *	8	
	--		
A	J.E.E. JOURNAL OF ELECTRONIC ENGINEERING, vol. 19, no. 189, September 1982, pages 113-115, Tokyo, JP; M. KUROHA: "Major properties and primary applications of photo-transistors"		
	--		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
X	EP-A-0 206 649 (CANON K.K.)		H 01 L
	* Page 21, line 17 - page 22, line 6; figure 6J *	8	
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A	US-A-4 633 287 (S. YAMAZAKI)		
	* Abstract; figure 7; column 9, lines 1-15 *	8	
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A	EP-A-0 339 386 (SIEMENS AG)		
	* Whole document *	8	
	-- ./.		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20th August 1991	DE LAERE A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- ☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid;

  namely claims:
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions,
namely:

See sheet -B-

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid,

  namely claims:
- ☐ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims,

  namely claims:

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 90 31 3687 -2-

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
T	J. ALLISON "Electronic Engineering Semiconductors and Devices", 2nd edition, 1990, pages 178-183, McGraw-Hill Book Company, Berkshire, GB; * Section 7.11 *	8	

			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner

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European Patent Office

EP 90 31 3687 -B-

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1-7: Photoelectric converting device of bipolar phototransistor type.

2. Claim 8: Bipolar phototransistor having an emitter lead-out which contacts the emitter regions with a metal-semiconductor junction.